

Mr. F. E. Beddard, F.R.S., Prosector to the Society, exhibited a skin of the rare Marsupial *Dactylopsila palpator* (A. Milne-Edw.), which had been placed in his hands by Dr. C. G. Seligmann, F.Z.S.

A collection of Molluscan Shells, Corals, &c. collected in the Pamban Channel, Southern India, was exhibited on behalf of Mr. C. M. Venkataramanujalu.

The Secretary, Dr. P. Chalmers Mitchell, F.R.S., exhibited preparations of the intestinal tracts of the Polyprotodont Marsupials *Phascogale penicillata*, *Sminthopsis larapinta*, and *S. crassicaudata*, made from specimens kindly lent him for the purpose by Mr. H. C. Beck, F.R.S., and remarked on the simplicity of the patterns displayed by the intestinal tracts of these and other *Dasyuridae* as contrasted with other Marsupials.

The following papers were read :—

1. On the Origin of the Mammal-like Reptiles. By R. BROOM, D.Sc., C.M.Z.S., Victoria College, Stellenbosch, S. Africa.

[Received August 1, 1907.]

(Text-figures 244-247.)

A considerable amount of discussion has recently been given to the question of the origin of Mammals, and so far from a general agreement having been arrived at, men of science are becoming more definitely arranged into two groups—those who believe that mammals are descended from Amphibia and those who hold that they sprang from Reptiles; and to judge by the reports of a recent Congress, the opposing opinions seem to be held with a warmth reminiscent of a bygone age. At the meeting of the British Association in South Africa in 1905 I read a paper (1) endeavouring to show that the case for descent of the mammal from a Cynodont reptile, or a closely allied form was very strong, and that the main objection urged against it from the mode of development of Meckel's cartilage in the mammal is of no weight, the condition of affairs being exactly what we should expect from our knowledge of the Cynodonts. In the present paper I wish to say little on the origin of mammals, as the British Association paper has recently been published, and there is little to add to it that is new; but I desire to call attention to some new discoveries that throw most important light on the origin of the mammal-like reptiles. The Anomodonts, the Cynodonts, and the Therocephalians are fairly well known; some of them even as well known as regards their

osteology as living reptiles, but concerning their origin or nearest reptilian allies we have hitherto known little or nothing.

Though Owen (2), as far back as 1845, recognised mammal-like features in the Anomodont dentition, and also later when he described the skulls of Cynodonts and Therocephalians, Cope (3) seems to have been the first to have expressed the view that the mammalian resemblances found in certain Permian reptiles were due to a genetic affinity. Between 1875 and 1878 the first remains of Pelycosaurian reptiles were discovered, and Cope recognised in them so many mammalian characters that he suggested that the Mammalia had probably been descended from them. As the South African Anomodonts had also a number of similar mammal-like characters, he united the two suborders in a new order Theromorpha, a name afterwards changed to Theromora. As the result of later work on the Pelycosaurians by Baur and Case (4), and on the South African forms by Seeley and myself, it became manifest that the group Theromorpha is not a natural one, the Pelycosaurs being more nearly related to the Rhynchocephalians than to the mammals. Osborn (5) in 1903, in his most important paper on the classification of the reptiles, reviewed the recent work and came to the conclusion that the reptiles had very early become specialised along two very distinct lines—the one giving rise to the lizard-like forms and the other to the mammal-like. The former group he called the Diapsida and the latter the Synapsida. In the Diapsida he placed all the primitive Rhynchocephaloid groups, including the Pelycosauria, as well as most of those reptilian orders which seem to have sprung from a *Sphenodon*-like ancestor. In the Synapsida he placed, besides the Anomodonts and “Theriodonts,” the Chelonians and Plesiosaurians. Though most recent opinion has been in favour of some such division of the Reptilia, it seems doubtful if the Chelonians and Plesiosauria should be placed in the Synapsida, and I am inclined to agree with Boulenger (6) in placing them rather with the Rhynchocephaloid groups. It seems to me, however, advisable to retain Osborn’s names for the two large groups, but making the Synapsida only include the mammal-like forms, with possibly the Pareiasauria.

Within the last few years our knowledge of the Synapsida has greatly increased. Four well-marked suborders of mammal-like reptiles are recognised, viz.: the *Anomodontia* (Owen), for the Dicynodon-like forms; the *Cynodontia* (Owen), for the reptiles like *Galesaurus* and *Gomphognathus* with a well-developed secondary palate; the *Therocephalia* (Broom), for the mammal-like reptiles, such as *Scylacosaurus*, which have a Rhynchocephalian palate; and the *Dinocephalia* (Seeley), for those specialised forms which resemble *Titanosuchus*. For these four suborders the term *Therapsida* has been proposed (7) as an embracing order. *Pareiasaurus* and its allies, such as *Tapinocephalus*, *Propappus*, &c., may perhaps be considered to form a second order of the Synapsida, the *Pareiasauria* Seeley.

The early orders of the Diapsida are less fully known than those of the Synapsida. The Pelycosauria are, thanks to the labours of Cope, Baur, and Case, now fairly well known, though there are still a number of serious blanks in our knowledge. The digital formula is not certainly known and more definite knowledge is required of the structure of the tarsus. Even in the skull there is still a little doubt about the structure of the posterior temporal region. Most authorities, however, seem agreed in placing the order in the Diapsida.

The Procolophonia are much better known, nearly every detail in the osteology of *Procolophon* being as fully known as in recent animals. In most of its characters the latter comes nearer to the early Rhynchocephalians than to the mammal-like forms. The digital formula is that of the lizards—2, 3, 4, 5, 3; there are well-marked abdominal ribs, the vertebrae are notochordal, the pre-vomers carry teeth, there is a quadrato-jugal bone, and the very small coronoid process is formed by a distinct coronoid bone and not by the dentary. It shows affinities, however, with the mammal-like groups in having a well-developed precoracoid, but this is a character which must have been possessed by early Diaptosaurians, as it is met with in the Pelycosaurians, in *Mesosaurus* and in *Heleosaurus*. Most of the other important characters are common to the early Diapsidan and early mammal-like forms—*e. g.*, the plate-like pelvis, the intercentra, the pro-atlas, and the columella cranii. From the consideration of these points I have expressed the opinion that *Procolophon* should be placed among the early members of the Diapsida rather than among the Synapsida.

While the Pelycosauria and the Procolophonia seem to be Diapsidan orders, it must nevertheless be admitted that both show certain resemblances to the mammal-like groups. As already mentioned, Cope believed the Pelycosaurs to be closely allied to the South African "Theriodonts," and *Procolophon* has been placed among the mammal-like forms by Seeley (8), Boulenger (6), and others. The most striking resemblance is in the shoulder-girdle with its well-developed precoracoid. As, however, an ossified precoracoid is found in the "Cotylosauria" and even occasionally among the Stegocephalia, we should naturally expect it to be met with in the early forms of both Synapsidan and Diapsidan reptiles. The digital formula of the Therocephalians and other Therapsida, viz. 2, 3, 3, 3, 3, marks them off fairly distinctly from the Diapsidans with a typical formula of 2, 3, 4, 5, 3. Still, when dealing with Permian reptiles, we find the Diapsidan and Synapsidan types approach each other so markedly that we are constantly in doubt about the position of individual forms. No distinction can be found in the shoulder-girdle, the palates are similar and both have plate-like pelvis; and it becomes manifest that the two groups have had a common ancestor, or that one of the groups has sprung from a member of the other.

I have been inclined to find the common ancestor in the some-

what artificial group "Cotylosauria," a view also supported by Osborn (5) and Broili (9), while Boulenger (6) is inclined to place the common ancestor among the Stegocephalia. Part of our difficulty consists in our not knowing very clearly what a Cotylosaurian is. The term was proposed by Cope for reptiles resembling *Diadectes* and *Empedias*, and many other forms were afterwards included, for the most part very imperfectly known, but supposed to agree with *Diadectes* in having the temporal region roofed. Case has recently shown that in some members of the Diadectidæ there is a small temporal fossa, while in the structure of the palate and some other points they differ greatly from other known forms, such as *Pariotichus*, and he proposes to remove them from the Cotylosauria altogether and place them in another order Chelydosauria. Broili's (9) recent work on *Labidosaurus* shows that we have here a fairly highly organised type approaching in many points the Procolophonia. Then there is *Pareiasaurus*, which is often also placed in the Cotylosauria, and which agrees with most of the genera in having the temporal region roofed, but differs markedly in a number of other points. Whether it is possible to keep the Cotylosauria as a superorder embracing a number of suborders which differ greatly can only be satisfactorily answered when more is known of the American types. In the meantime it seems better even to multiply the already large number of reptilian orders or suborders than to group together in an artificial manner forms that have little affinity.

As possible ancestors of the Synapsida and Diapsida we may dismiss the Diadectidæ as too specialised. The Pareiasauria, while they might be considered as ancestral to the mammal-like forms, are much too specialised to have been the ancestors of the Diaptosaurians, even though they still seem to retain the digital formula 2, 3, 4, 5, 3 *. The Pariotichidæ, on the other hand, have most of the characters we should want in the common ancestor of the later reptiles. The few known specimens, however, have lost the cleithrum which the ancestor must have had, as it is still found in the Anomodonts. *Pareiasaurus* and the Diadectids have it well developed, and it is not unlikely that forms may yet be discovered resembling *Pariotichus* and *Labidosaurus*, but retaining the cleithrum. Such a form might well be the looked-for ancestor.

Until recently the gap between the Therocephalians and the Cotylosaurs has been a fairly wide one, but a specimen has just been discovered which largely bridges it over. This is a small animal found at Victoria West. It is so well preserved that, with the exception of the temporal region, the palate and the tarsus, almost every detail of the anatomy is known. It has been named

* There has been some difference of opinion on the digital formula of *Pareiasaurus*, Boulenger definitely stating that it is 2, 3, 3, 3, 3. I have elsewhere shown (10) that in the very closely allied Pareiasaurian genus *Propappus* there is reason to believe that the formula is 2, 3, 4, 5, 3.

Galechirus scholtzi (11). The facial region is not unlike that of *Palaeohatteria*, there being no specialised canine. The lower jaw in general structure is essentially similar to that of the Anomodonts and differs from that of the Therocephalians in the absence of the large coronoid process of the dentary. The shoulder-girdle is like that of the Therocephalians and differs from that of the Anomodonts in the absence of the cleithrum. The humerus, ulna, and radius are like those of the Therocephalians, except that the ulna has no olecranon process. The carpus is very like that of the Anomodonts, and the digital formula is 2, 3, 3, 3, 3. There are intercentra in the cervical region and the ribs are single-headed. There are large numbers of slender abdominal ribs. The pelvis is plate-like, with the ilium small and passing upwards.

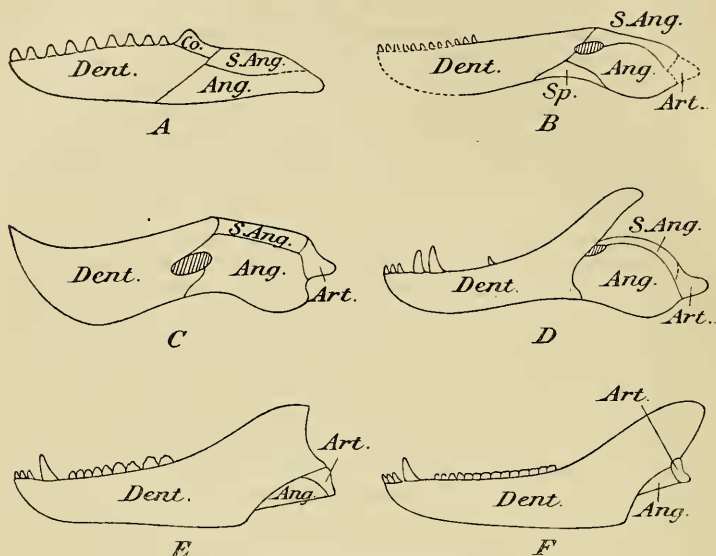
It will be seen that we have here a form which agrees with the mammal-like reptiles in the digital formula, in the structure of the shoulder-girdle, and for the most part in the limbs, but with a somewhat more primitive mandible, but which differs from them and agrees with the Diapsidan reptiles in having abdominal ribs and a plate-like pelvis. Had the manus not been preserved, I should have placed the form somewhere near the Pelycosauria, and the Procolophonina among the primitive Diaptosaurians; and had the mandible not been so essentially Anomodont, I should still have done so in spite of the digital formula. But the combination of characters shows that we have a form on the mammalian line, but not far removed from the Diaptosaurian or Cotylosaurian origin. Exactly where the point of origin has been is not clearly indicated, but the descent has most probably been either from a generalised Cotylosaurian or from a primitive Diaptosaurian. How the formula 2, 3, 4, 5, 3 was changed into 2, 3, 3, 3, 3 is not known, but in *Galechirus* we see some indication of the change. The metacarpals increase in size from the first to the fourth, just as is usually the case in Diapsidans, and this seems to show that the limbs were directed outwards from the body considerably, as in lizards, and that the reduction had but recently taken place. In the Therocephalian *Theriodesmus* (12) there seems from the figures to be some indication of a transition from the Diapsidan to the Synapsidan formula, but in an undoubted Therocephalian pes I have examined there is not the slightest indication of the larger formula, the numbers being the typical 2, 3, 3, 3, 3, and I feel inclined to believe that the change has taken place in two rapid stages, 2, 3, 3, 4, 3 and then 2, 3, 3, 3, 3.

In the accompanying figures the development of a number of important structures is traced through the various groups that lie between the Cotylosaurs and the Mammals. The types in no case lie in the direct line of descent and are only taken as the best-known examples of the different stages of the development.

I shall not take into consideration the skull generally, as though it is well known in all the Therapsidan suborders it is

very imperfectly known in the Cotylosaurians, and even in the Pelycosaur there are one or two points in doubt, and in *Galechirus* both the palate and temporal region are unknown.

Text-fig. 244.



Mandibles of Mammal-like Reptiles.

- A. *Procolophon trigoniceps*.
 B. *Galechirus scholtzi*.
 C. *Dicynodon jouberti*.

- D. *Lycosuchus vanderrichti*.
 E. *Cynognathus platyceps*.
 F. *Gomphognathus kannemeyeri*.

Ang., angular; Art., articular; Co., coronoid; Dent., dentary;
 S.Ang., sur-angular; Sp., splenial.

The mandible is, however, well known in most types. In *Procolophon* the anterior half of the jaw is formed of two boxes, the dentary forming the outside and supporting the teeth and a large splenial, which forms the greater part of the inside. Immediately behind the row of teeth is a well-developed little coronoid bone. On the inner side, at the back of this bone and near the top of the jaw, is a large oval opening into the large cavity of the posterior part of the mandibles. On the outer side of the jaw just behind the dentary is seen the large angular and surangular, each forming about half of the outer surface of the posterior half of the jaw. The angular appears to pass back to the angle of the jaw and to form the whole of the inner side of the posterior part, the surangular forming the upper border. The articular is small and wedged in between these two bones. In *Pareiasaurus* there is certainly a large angular and a large splenial a little like that in *Procolophon*, but the posterior part of

the jaw is not well known. In *Dimetrodon* the jaw bears considerable resemblance to that of *Procolophon*. There is a large splenial on the inner side and a large angular on both the inner and outer sides of the posterior part. There is also a large surangular and a small articular. There is some evidence of a coronoid element. In front of the articular on the inner side a distinct element called the prearticular is said to occur.

In *Galechirus* only the outer side of the jaw is known, and it differs from that of the early Diaptosaurian types mainly in the absence of a distinct coronoid bone. The angular forms more of the outer surface and probably less of the inner.

In the Anomodont such as *Oudenodon* (13), the jaw is fairly similar to that of *Galechirus* except that there are no teeth. On the outer side the angular is a large bone somewhat oval in shape which forms the greater part of the posterior half of the jaw. The surangular lies above it, but is for the most part hidden by it. There is no coronoid bone. The splenial is well developed. The articular is only in part hidden by the angular.

The mandible of the Therocephalians is pretty fully known, almost all details being known in both *Lycosuchus* (13) and *Hyanasuchus* (14). The only important difference between this type of jaw and that of the Anomodont is that the dentary has its upper and posterior end developed into a large coronoid process.

In the Cynodonts the mandible differs greatly from that of the Therocephalians, owing to the dentary becoming greatly developed and the other elements greatly reduced. The dentary forms not only a large coronoid process but nearly the whole of the back part of the jaw, and hides the whole of the surangular and much of the angular and articular.

In the mammal the dentary forms the whole jaw, the rudimentary elements having disappeared.

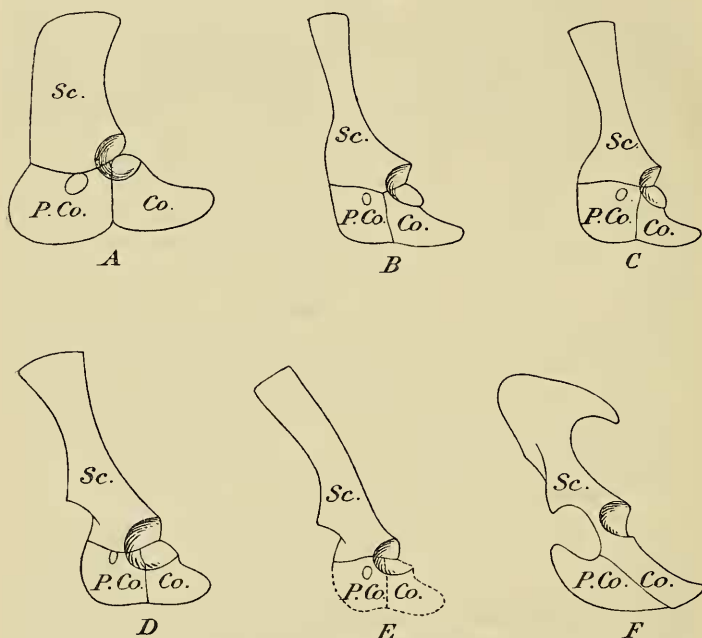
The next important structure whose evolution may be considered is the shoulder-girdle. Fortunately this is well known in most groups.

In the Labyrinthodonts the girdle is made up of a large flat interclavicle, with two large flattened clavicles and a pair of slender cleithra—these membrane-bone elements supporting the cartilage-girdle proper, which no doubt was made up of a permanently cartilaginous precoracoid and coracoid with an ossified scapula. Of course in most specimens of the girdle proper only the scapula remains as a fossil. In some forms, e. g. *Eryops*, the whole girdle is ossified and we find well-developed coracoids and precoracoids.

In most of the Cotylosaurs the same eleven elements are met with. In the Diadectidæ there is a large precoracoid and coracoid, with a large scapula which is supported in front by a well-developed cleithrum. In *Pariasaurus* there is also a well-developed cleithrum, and the shoulder-girdle for the first time has a distinct acromion formed by a twisting of the anterior

scapular border. In *Pariotichus*, according to Case, there is no cleithrum, and in none of the members of the Diapsidan phylum does the cleithrum ever reappear. The Pelycosaurs, *Procolophon* and its allies and *Mesosaurus*, all retain the ossified precoracoid, but soon this too becomes lost as a bone and is never again found in any of the Diapsida. Anterior developments of the scapula sometimes take the place of the lost precoracoid, as in the Chelonia, the Plesiosaurs, and in the Ostrich; and the coracoid and scapula occasionally have anterior developments which are somewhat

Text-fig. 245.

Shoulder-girdles of Mammal-like Reptiles and of *Ornithorhynchus*.

A. *Procolophon trigoniceps*.
 B. *Galechirus scholtzi*.
 C. *Ictidosuchus primævus*.

D. *Oudenodon baini*.
 E. *Galesuchus browni*.
 F. *Ornithorhynchus anatinus*.

Sc., scapula; Co., coracoid; P.Co., precoracoid.

precoracoid-like as in the Lizards, but a distinct precoracoid never appears when once lost. In *Procolophon* the scapula is short and broad, the precoracoid of large size with a round foramen, and the coracoid also well developed. These three elements are never anchylosed even in old specimens. The

clavicle passes up along the front of the scapula, taking the place of the lost cleithrum. The interclavicle is large and T-shaped. In *Mesosaurus* and *Heleosaurus* (11) the scapula, coracoid, and precoracoid are completely anchylosed.

In *Galechirus* the scapula is long and narrow, except at the lower end, where it broadens out for articulation with the precoracoid and coracoid. There is no distinct acromion, though the anterior border of the scapula is somewhat twisted. The coracoid and precoracoid are well developed, but much smaller than in *Procolophon* and not anchylosed. The interclavicle has a large and rather broad posterior portion. The clavicles are well developed and appear to pass a considerable distance up the front of the scapula, but there does not appear to be a cleithrum.

In the *Terocephalia* the shoulder-girdle is not very fully known. In *Ictidosuchus* (15) only the cartilage-bone elements are preserved. The scapula is long and slender in its upper part and broad at the lower end. There is no distinct acromion and no twisting of the anterior border of the bone. The precoracoid is a large flat, somewhat square-shaped bone with the foramen completely surrounded by the bone. The coracoid is smaller and of the usual shape. It is not known whether there is a cleithrum or not.

In the *Anomodonts* the shoulder-girdle is well known. The scapula is long and well developed and has a well-marked acromion. The precoracoid has a large foramen, which is in part formed by the scapula. One of the most noteworthy characters in this type is the presence, at least in *Dicynodon* and *Oudenodon*, of a distinct cleithrum. The interclavicle in some forms is short, e. g. *Lyztrosaurus* (16), while in others, e. g. *Dicynodon*, it is elongated.

In the *Cynodontia* the shoulder-girdle is not fully known. Seeley (17) has figured the scapula with portions of the coracoid and precoracoid of *Cynognathus*, and I have recently figured an imperfect shoulder-girdle of *Elurosuchus* (18). The scapula is well developed and somewhat like that of the *Anomodonts*, having a well-formed acromion. The coracoid and precoracoid, so far as known, are also *Anomodont*-like. There is no evidence of a cleithrum. There is a well-formed clavicle in *Diademodon*, but the interclavicle is not yet known in any *Cynodont*, but probably occurs in all species.

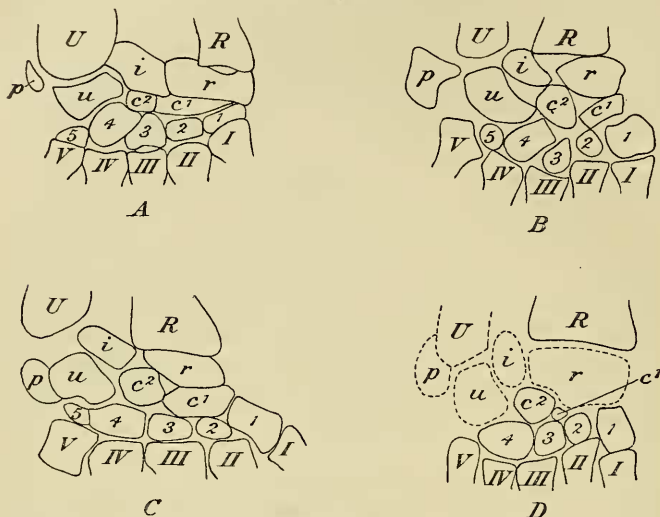
In the closely allied *Monotremes* the only essential difference in the shoulder-girdle from the *Cynodonts* is in the precoracoid, which has become reduced and no longer articulates with the scapula.

In *Marsupials* and *Eutheria* the precoracoid is lost as a skeletal element and the coracoid rudimentary, but, as I discovered some years ago (19), the *Marsupial* at birth still has a large coracoid which articulates with the sternum as in the *Monotremes*.

The examination of the humerus, radius, and ulna in the various

groups does not throw much light on their affinities, but from the study of the carpus some interesting facts are obtained.

Text-fig. 246.

Carpus of *Sphenodon* and of Mammal-like Reptiles.

A. *Sphenodon punctatus* (after
Howes and Swinnerton).
B. *Galechirus scholtzi*.

C. *Oudenodon trigoniceps*.
D. *Galesuchus browni*.

c^1 , c^2 , centralia; i , intermedium; p , pisiform; R , radius; r , radiale; U , ulna;
 u , ulnare; 1, 2, 3, 4, 5, carpalia; I, II, III, IV, V, metacarpals.

In the case of the fossil carpi the elements are figured exactly as found.
In *Galechirus* and *Oudenodon* there is evidently a slight lateral displacement.

The carpus is practically unknown in any Cotylosaurian. Case has endeavoured to restore that of *Pariotichus* (20), but too many points are left in doubt to make it advisable to take it at present into consideration. Fortunately the carpus is well known in the two very primitive Diapsidan genera *Dimetrodon* (21) and *Procolophon* (22), as well as in the pre-Cotylosaurian genus *Eryops*. In all three genera the carpus is so essentially similar, and so like that of *Sphenodon*, that we may feel pretty sure the Cotylosaurian carpus was also of the *Sphenodon*-type.

In *Dimetrodon*, as shown by Case (21), there is a large radiale and ulnare, with a smaller intermedium between two well-developed centralia, of which the inner is the larger, and a fair-sized pisiform. In the distal row are five carpalia, of which the second is the largest.

In *Procolophon* (22), as I showed some time ago, the carpus

has the usual four elements in the proximal row, two centralia, of which the outer is the larger, and four distal carpals. It differs from that of *Dimetrodon* and agrees with that of *Sphenodon* and most reptiles in having the pisiform articulating with the ulna. There is also evidence of specialisation in the 5th carpal being lost, though retained even in *Sphenodon*.

In the recently discovered *Galechirus* the carpus is preserved in perfect condition. In the proximal row are a large radiale and ulnare, with a smaller but well-developed intermedium and pisiform. In the distal row are five carpalia, but the 5th is small. In the centre of the carpus are two centralia, of which that to the radial side is the smaller and lies between the radiale and the 1st carpal. It will be seen that this small animal with a mammalian digital formula has nevertheless a carpus almost exactly similar to that in *Sphenodon*.

The only Therocephalian carpus at present known is that of *Theriodon* (12), which, though well preserved, has unfortunately the elements somewhat displaced. Restorations have been attempted by Seeley, Bardeleben, and myself. We may feel pretty certain that there are the usual four bones in the proximal row, and also that there are only four in the distal row. There are apparently two centralia, one of which is rudimentary.

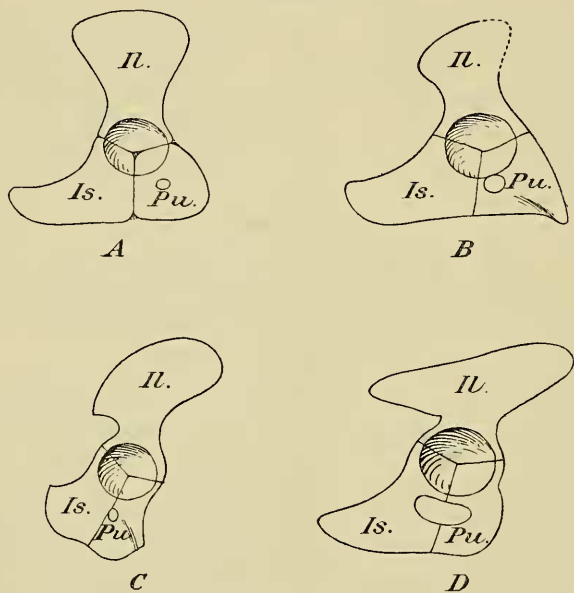
In the Anomodontia the carpus is much better known, that of both *Oudenodon* and *Opisthoctenodon* (23) being represented by perfect specimens. In *Oudenodon* the arrangement is almost precisely similar to that in *Galechirus*, there being two large centralia, of which the inner lies between the radiale and the 1st carpal. There is a small but distinct 5th carpal. In *Opisthoctenodon* there is no 5th carpal and the inner centrale is not so markedly between the radiale and 1st carpal.

Until recently very little has been known of the Cynodont carpus. A very imperfect carpus of *Microgomphodon* (24) has been figured by Seeley, but it is too badly preserved to help us much. About six months ago I figured the carpus of a new Cynodont *Elurosuchus* (18), which shows at least the distal carpals and the centralia in true position, and though the proximal elements are somewhat displaced, we may feel fairly sure of their relations. There are but four distal carpals, the 5th being lost as in Mammals. Of the centralia that to the radial side is rudimentary, the other being large, from which we may infer that the centrale of the mammalian carpus corresponds to the outer of the two centralia of the primitive reptilian carpus. In the proximal row there are probably the usual four bones. We thus find that the Cynodont carpus is identical with that of the typical Mammal, except that whereas in the latter there is only a C², the former has, in addition to a C², a rudimentary C¹.

The evolution of the pelvis is now pretty well known. Perhaps the most primitive type of pelvis in any land animal is that seen in some of the Stegocephalia, such as *Discosaurus*. Here we

have an ilium with a fairly well-marked crest directed mainly backwards, an ischium of the flat semicircular type, and a rounded pubis. It is from some such type as this that all the later pelvic types have sprung. In the early Diapsidan reptiles the pelvis is but little modified from the early type. In *Procolophon* the pubis and ischium are flat and lie in one plane, forming the typical plate-like pelvis. The ilium has a fairly broad crest. In *Palaeohatteria* the pelvis is almost exactly similar, and in a large number of the later Diapsidan orders the same type is retained with little modification. In the Pelycosauria, as exemplified by *Embolophorus* (25), the pelvis is of the plate-like type, but the ilium differs from the earlier forms in having the crest directed very markedly backwards.

Text-fig. 247.



Pelvis of Mammal-like Reptiles.

A. *Procolophon trigoniceps*.
B. *Galechirus scholtzi*.

C. *Oudenodon trigoniceps*.
D. *Diademodon mastacus*.

Il., ilium; Is., ischium; Pu., pubis.

Among the Colytosaurs, and even above the Labyrinthodonts, the ilium presents a number of modifications in connection with the various habits of the animals. In *Eryops* the ilium is long

and slender and passes straight up. In *Labidosaurus* (9) the ilium is relatively small and is directed somewhat backwards. In *Pareiasaurus* (26) the pelvis has a large ischium and a smaller pubis, and though much specialised, they can still be referred to the plate-like type. The ilium, however, is quite unlike that of any of the early types and resembles that of the Anomodonts and Mammals in having a large crest which is directed markedly forwards.

In passing to the Therapsida the earliest type known is that found in *Galechirus*. Here the ilium is directed upwards and the crest is short. The pubis and ischium are of the plate-like type. The pubis is nearly square, with the anterior and outer angles bent downwards, so that, though the ischia make with each other an angle of about 90° , the fronts of the pubis are nearly in line. There is a round pubic foramen. The ischium is, as usual in the plate-like type, longer than broad.

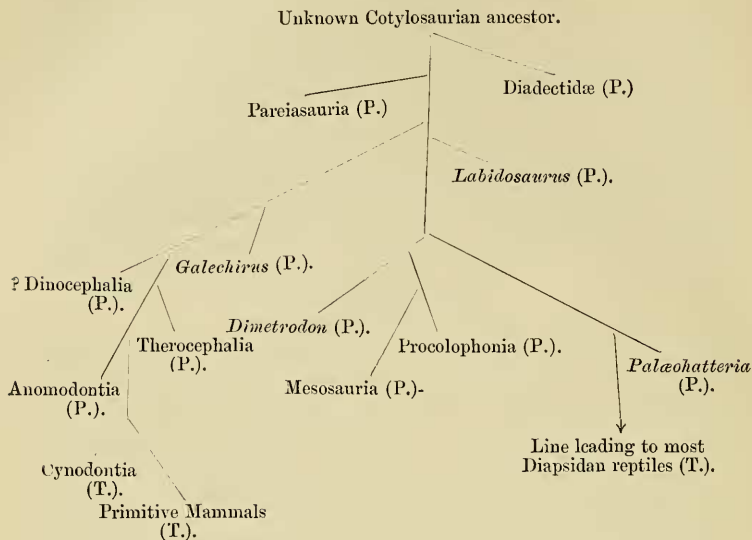
The pelvis in the typical Therocephalians is unknown. In the Dinocephalian *Titanosuchus* the ilium is directed mainly upwards and has a short crest. The pubis and ischium are unknown.

In the Anomodontia the pelvis is well known in a number of genera. The type seen in *Oudenodon* differs little from that of the other known forms. The ilium is directed well forwards and has a large crest very like that in some Mammals. The pubis and ischium are somewhat removed from the plate-like type. The foramen, though small, lies between the pubis and ischium, and is thus a true obturator foramen.

In the Cynodonts the pelvis is well known in *Cynognathus* (17) and *Diademodon* (27), and less perfectly in some other genera. In general, the structure is strikingly mammal-like. The ilium is directed mainly forwards and has a very long crest. The pubis and ischium are almost typically mammalian, owing to the presence of a large obturator foramen.

From the consideration of the comparative anatomy of these skeletal structures it will be seen that the mammal-like reptiles form a well-defined group, whose earlier members show so much affinity with the primitive Diaptosaurians and with the higher Cotylosaurians as to render it highly probable that from some Cotylosaurian ancestor all the later reptiles are descended. On the other hand, the higher mammal-like reptiles approach so closely to the mammals that it is not always possible to distinguish between them. *Tritylodon* is held by many to be a reptile; by others it is believed to be a mammal. *Dromatherium*, *Microconodon*, and *Karoomys* are generally believed to be mammals, but it is just possible they may be reptiles; while *Sesamodon* and *Melinodon*, which are believed to be Cynodont reptiles, may possibly prove to be mammals. The difference between a Cynodont reptile and a Monotreme is less than the difference between a Monotreme and a Marsupial, and this again is not much greater than that between a Marsupial and an Insectivore.

The relationships of the various groups dealt with above may be represented by the following diagram :—



“P.” signifies that the types or groups occur in the Permian beds; “T.” that they first occur in Triassic beds.

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